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COMMERCIAL PRODUCTION OF GRAPE SYRUP

BY

W. V. CRUESS

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COMMERCIAL PRODUCTION OF GRAPE SYRUP

By W. V. Cruess

Since the publication of Bulletin 303 of this Station* in 1918, marked progress has been made in methods of preparing grape syrup. Because of this fact and on account of the widespread interest of grape growers in the subject, the present publication has been prepared to supplement the information given in the bulletin cited above.

Syrup was produced from wine grapes and table grape culls in commercial quantities by several factories during the past season. Although certain difficulties were encountered, these were overcome and the product was marketed successfully, demonstrating that the manufacture of syrup offers a practical method of utilizing a large proportion of the state's wine grapes. However, it is recommended that all other methods, such as evaporation and grape juice manufacture also be employed, because it will not be possible during the next season to convert the whole crop into syrup.

Several different types of syrup have been produced. Of these, the following are most promising: (1) a syrup of deep violet-red color and rich berry-like flavor made in vacuum pans of standard design; (2) a syrup, red or white as desired, made by concentrating fresh Muscat or other highly flavored juice by the freezing process and blending this with a syrup of high sugar content made by the vacuum pan process; (3) a red or white syrup made in a proprietary patented vacuum pan so designed that part of the natural grape flavor is condensed and returned to the syrup. These different varieties will be discussed in the order given above.

RED GRAPE SYRUP BY STANDARD VACUUM PROCESS

It is believed that the manufacture of this syrup offers a greater possibility of utilizing a large proportion of the wine grape crop of the state than does any other one grape product, for the following reasons: It requires only the use of present winery machinery plus vacuum pan equipment of the kind already installed in some wineries.

* Grape Syrup: a Preliminary Report, by F. T. Bioletti and W. V. Cruess, Bulletin 303, California Agricultural Experiment Station.

Many former winemakers are trained in the use of such vacuum equipment and grape-handling methods, so that the training of specialists will not be necessary. The equipment is standardized and produced by a number of firms and therefore may be had before the coming season. No patent rights are violated in making this syrup. Therefore, any one may undertake its production. During the past season syrup of this type has sold at wholesale in many instances for more than three dollars per gallon. This price represents from $125 to $150 gross for the product from a ton of fresh grapes; or is about the equivalent of 20c per pound for raisins made from grapes of the same quality.

Equipment Necessary.—The following list includes the essential items of equipment:

1. Crusher and stemmer (now installed in all wineries).
2. Basket or rack and cloth press (old-style continuous press not satisfactory).
3. Device for heating crushed grapes for color extraction.
4. Tanks and vats for leaching pomace and storing juice and syrup.
5. Filter or filter press.
6. Vacuum pan fitted with a barometric condenser and dry vacuum pump or a pump only which will maintain a twenty-eight to twenty-nine inch vacuum during operation of pan.
7. Can-sealing machine or bottling machine. Barrels may be used for bulk goods.

Grapes for Red Syrup.—All varieties of wine grapes may be used. A syrup of intense red color can be made even if 50 per cent of the grapes used are of white varieties. The grapes should be thoroughly ripe to obtain the highest yields and best quality. Moldy or fermenting grapes give an inferior product.

Crushing and Stemming.—These operations are carried out as for wine making. Stems should be well removed in order to prevent the syrup becoming too astringent in flavor.

Heating to Extract Color.—The color of grapes is located in the skins and does not dissolve in the juice unless the grapes are heated sufficiently to cause the "color to flow." The color will dissolve slowly at 105° F. to 120° F. and almost instantly at 160° F. to 170° F. The higher temperatures have proved most satisfactory from the practical standpoint, although a better flavored product is obtained at the lower temperatures.

Iron should not be permitted to come in contact with the juice during heating, because it dissolves rapidly, injuring the flavor and color.

Copper dissolves to a slight extent; it is doubtful whether injurious amounts of this will dissolve during heating of the crushed grapes. Aluminum, tin, "Monel" metal, or silver-plated copper may be used safely.

Tin-lined copper, glass-lined steel, or plain aluminum steam-jacketed kettles have all been successfully used.

Many different forms of heaters have been used in commercial practice. Vats fitted with steam coils have been used but are difficult to stir and to empty. The simplest heater observed consisted of a 1500-gallon

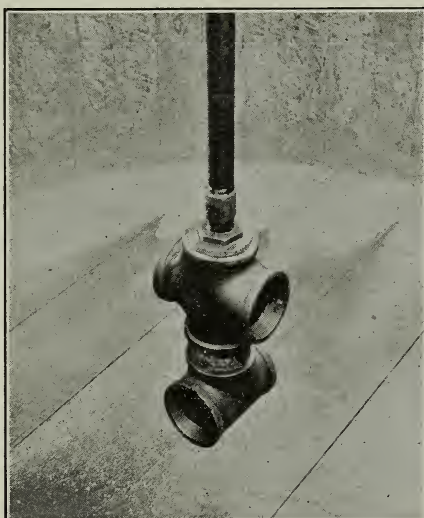

Fig. 1.—Simple form of steam injector used in the Greco Company's cannery at San Jose to heat crushed grapes.

tank in which was placed a large two-way fitting 2½-inch or 3-inch size attached to an overhead steam line, and with fitting left open at sides and bottom. When steam is passed through this device into the crushed grapes it acts as an injector, drawing the juice and grapes through the side openings and forcing them out through the bottom opening. This also stirs the grapes thoroughly. Aluminium or other resistant metal (not iron) must be used. The tank must be placed above the level of the press baskets and equipped with a large outlet and chute to permit rapid emptying of the contents into the press baskets.

The crushed grapes must be stirred to prevent overheating and to accomplish uniform and rapid heating.

As soon as a thermometer suspended in the crushed grapes indicates a temperature of 160° F. to 170° F. the heated grapes must be transferred at once to the press. A juice of better flavor and of as deep color can be obtained by heating the crushed grapes to only 110° to 120° F., transferring to wooden vats and allowing to stand overnight. This lower temperature is less injuriors to the flavor, but is more troublesome to apply.

Another system that has been used is to crush the grapes into open vats, drain off the juice, heat the juice to 165° F. to 170° F. and return it to the crushed grapes. This is continued until the mixture reaches the desired temperature. However, for regular commercial operation, it is believed that the injector type of heater will prove one of the most practical heating devices.

Pressing.—If the grapes have been heated to 160° F. or higher, they should be pressed at once to avoid extraction of too much tannin from the seeds. If it is necessary to allow the grapes to stand several hours after heating, lower temperatures should be used.

For large-scale operations the basket type of hydraulic wine grape press is most convenient and is efficient. Several baskets are needed for each press in order that the grapes may drain well before pressing. Rack and cloth presses, such as those designed for pressing apples, are used in eastern grape-juice factories for pressing heated grapes for grape juice manufacture. They produce very high yields but require more labor than the basket press. Small syrup factories have used hand power, basket screw presses, but these are too expensive to operate upon a large scale. A successful continuous press has recently been developed.

It will usually be desirable to line the press basket with burlap to prevent the grape pulp escaping between the press staves.

Well-drained heated grapes may be quickly pressed and a large yield of juice obtained because heating destroys the slimy nature of freshly crushed grapes and breaks down the juice cells.

Extracting Juice from Pomace.—The press cake or pomace will amount to about 300 to 500 pounds per ton of grapes, and contains juice equal to over 50 per cent of its weight. This juice may be recovered by leaching the pomace with water. A simple method is to mix the pomace with sufficient water in the heating tank to render the mixture plastic. It may then be heated to about 120° F. and pressed. This dilute pressed juice may be used to extract a second lot of pomace, thereby materially increasing its sugar content. In laboratory tests a liquid containing several per cent of sugar was obtained by a

second extraction of the pomace, although it is doubtful whether a second treatment would be made in commercial practice.

It is also possible to extract the juice from the pomace by the diffusion process used in European countries or by the sprinkling method, formerly used in California wineries.

The sugary solution obtained from the pomace should be concentrated separately from the juice obtained by the first pressing because of the inferior quality of the former.

Clearing the Juice.—The juice from the press is cloudy and should be made clear before concentration if a syrup of high quality is to be produced. Straining the freshly pressed juice through screens will remove the coarse particles of pulp, seeds, etc. Settling twelve to fifteen hours in rather shallow tanks, such as fermentation vats, will permit much of the suspended matter to settle. The settled juice may be drawn off the sediment and filtered through a wood-pulp filter of any of the types formerly used in wineries. The pulp used should not be excessively fine, as the filtration will otherwise be very slow or impossible. The pulp must be removed and washed much more frequently than where wine or vinegar is filtered. This makes the installation of ample pulp-washing machinery and a large stock of filtering pulp necessary. If these precautions are observed it will be possible to filter the juice. Wooden frame filter presses equipped with coarse cloths will probably give good results and large capacity, although preliminary tests by one grape syrup factory and by a sweet cider factory indicate that considerable experimental work must be done before thoroughly satisfactory results can be obtained.

The sediment from the settling tank may be filtered in bag filters or may be mixed with the pomace during water extraction, when part of the sediment will adhere to the grape skins and stems.

Juice may be clarified by the addition of about four to five gallons of a solution of casein containing three ounces of odorless commercial casein per gallon. This solution is made by dissolving a weighed amount of the casein in dilute ammonia water, boiling off the excess ammonia and diluting with water so that each gallon contains three ounces of casein. This solution is added to the juice and thoroughly mixed with it. It will settle in eight to twelve hours if clarification has been successful and the clarified juice may then be filtered very easily.

In our experimental work the addition to each 100 gallons of juice of about eight pounds of Spanish Clay previously thoroughly ground with water to give a smooth fine-grained mud, will usually produce a rapid clarification, but gives a large amount of sediment.

Clarification will usually not be necessary or desirable, but may be employed if a brilliantly clear syrup is desired.

Concentration.—If grape juice is boiled down to a syrup in an open kettle the finished product will be dark brown in color and of a molasses flavor and odor, because the high temperature of boiling under atmospheric pressure caramelizes or scorches the grape sugar. If the atmospheric pressure is to a large degree removed by placing the juice under a vacuum the boiling point will be very greatly lowered, with the result that the grape sugars are not caramelized, much of the

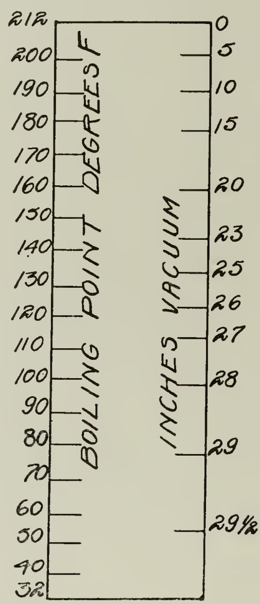

Fig. 2.—Chart showing relation between boiling point of water and vacuum in inches.

fresh grape flavor and aroma are retained, and the color of the juice is not injured. To obtain the best results a vacuum of at least twenty-eight inches should be employed, as this will give such a low boiling point that the syrup will not be injured appreciably. The relation between the boiling point and degree of vacuum as indicated by the "inches vacuum" on the gauge is shown in the above chart.

It will be seen from the chart that water under a 24 to 26-inch vacuum (the degree of vacuum ordinarily used in commercial practice) boils at about 140° F. to 125° F. Grape syrup will boil at temperatures about 10° F. higher than these. At 29 inches vacuum water

boils at about 75° F. and syrup at about 85° F.; temperatures no higher than mid-day temperatures in grape-growing districts during the picking season. To reach such a high degree of vacuum a "dry vacuum pump" in combination with a barometric condensor system will probably be most satisfactory. A wet vacuum pump plus a dry

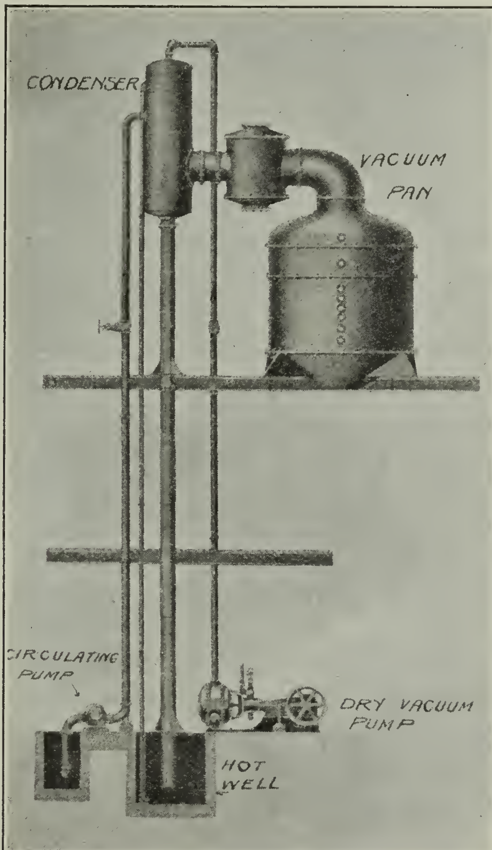

Fig. 3.—Pan equipped with dry vacuum pump and barometric condensor (courtesy of Ingersoll-Rand Company).

vacuum pump may also be used, but cost of installation and operation will usually be greater than with the barometric system.

The barometric condensing system consists of a condensing chamber connected to the vapor outlet of the vacuum pan into which chamber above the vapor entrance is led a jet of water, the vapors from the pan being condensed by contact with the water spray. The condensed

vapors and water flow by gravity into a vertical pipe below the condensing chamber. This pipe is over 31 feet in height and opens into an open tank or hot well open in turn to the air. The air and uncondensed vapor from the pan rise to the top of the condensing chamber and are removed by a dry vacuum pump. The water used for condensing the vapors from the pan is usually supplied by a circulating pump acting independently of the vacuum pump. Figure 3 illustrates the general appearance of a vacuum-pan installation consisting of pan, barometric condensor, dry vacuum pump, hot well, and circulating pump.

In addition to a good vacuum pump a large supply of water for condensing purposes is necessary to maintain a high vacuum. At 28 inches vacuum* and use of a barometric condensing system, approximately 5.5 gallons of water at 75° F. will be needed to condense each pound of water vapor; or, over forty gallons of water for each gallon of water evaporated from the juice. At 25 inches vacuum very much less water and at 29 inches more water is needed; that is, the higher the vacuum the more condensing water is needed.

Where the water supply is inadequate the water from the condensor may be cooled by use of a cooling tower or spray cooling system such as used in many industrial plants, thus permitting the water to be used over and over again, although the water lost by evaporation on the cooling tower or spray must of course be replaced.

The vacuum pan may, if properly equipped, be used continuously, juice being allowed to flow into the pan continuously and the syrup withdrawn from the pan continuously by a special pump. However, according to O. S. Newman, the ordinary syrup pan can not be used in this way except under a vacuum of twenty-five inches or less because the pump usually installed will not operate satisfactorily against a vacuum of twenty-six to twenty-nine inches; but it is very probable that this problem may be overcome by use of a pump of proper design.

Some operators prefer to use their vacuum pans by the "batch" system; that is, to allow juice to enter the pan and at the same time concentrating until the pan contains a full charge of syrup. When this reaches the desired concentration the pan is emptied and a new "batch" started. This is less convenient than the continuous system and reduces the capacity of the pan, but probably permits more accurate control of the composition of the syrup.

* Estimate furnished by Ingersoll-Rand Company.

The syrup should be concentrated until it will test at 60° F. at least 68° Balling, or 68° Brix, if it is to be held for more than a few weeks. We have found that syrup of 65° or 66° Balling will soon ferment and become moldy, but that syrup of 70° Balling will keep perfectly. Vacuum pans are equipped with a sampling device by which enough syrup may be removed for a Balling test. The Balling hydrometer

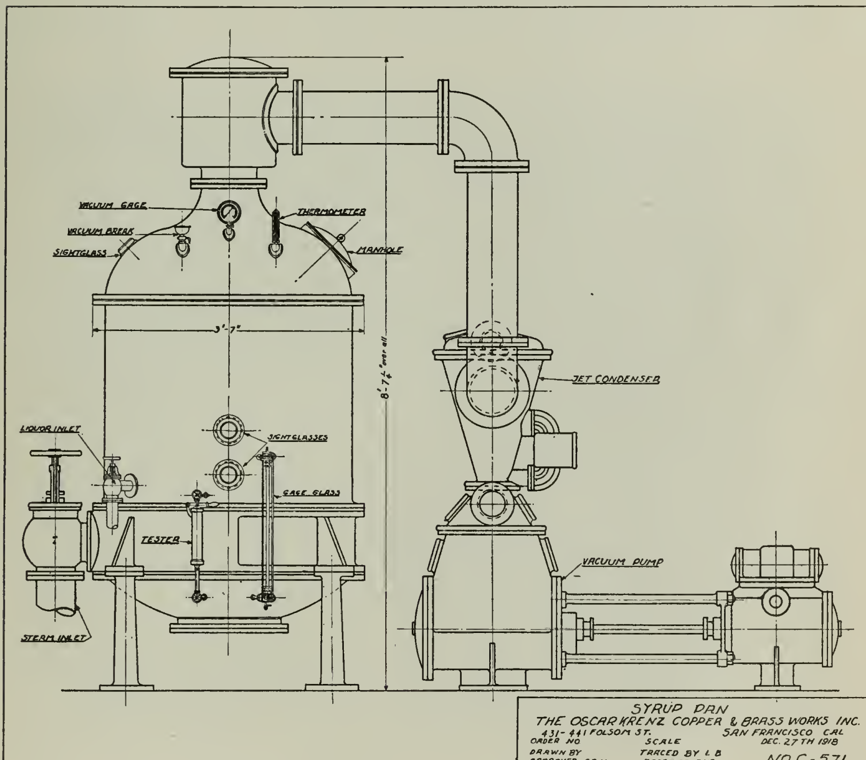

Fig. 4.—Sketch of a vacuum pan showing vapor condensor and wet vacuum pump connection (courtesy of Oscar Krenz Company).

used is calibrated from 0 to 70° Balling. A Brix hydrometer of the same range may be used because the Brix and Balling scales are practically identical. The temperature at which the test is made greatly affects the result; in making the test, a thermometer should be inserted in the sample with the hydrometer and correction made accordingly. The following table indicates the approximate number of degrees Balling or Brix to add to the reading shown by the hydrometer in a syrup of 60 to 70 degrees Balling or Brix.

Corrections to be made to Balling or Brix Readings on Account of Temperatures

Temperature, degrees F.	Degrees Balling or Brix to be added to hydrometer reading	Temperature, degrees F.	Degrees Balling or Brix to be added to hydrometer reading
64	.0	126	2.9
72	.3	130	3.1
75	.4	135	3.4
82	.7	140	3.7
86	.8	149	4.2
90	1.1	158	4.3
97	1.4	167	5.2
100	1.6	176	5.8
108	1.9	185	6.3
110	2.0	194	6.9
115	2.3	203	7.5
121	2.6	212	8.2

An example will make the use of the table clear. Suppose that a syrup sample from the vacuum pan tests 64° Balling or Brix and the temperature is 143° F. The temperature 140° F. is the nearest temperature given in table and the correction at 140° F. is 3.7° Balling or Brix; therefore, the approximate corrected reading will be 64 + 3.7 = 67.7° Balling or Brix.

Cooling the Syrup.—When the syrup reaches the desired concentration it may be drawn off and stored to permit separation of cream of tartar before placing in final packages for sale; or it may be drawn directly into cans or other small containers. If it is to be stored in large lots, the syrup must be cooled to about 100° F. or less, in order that caramelization of the flavor and browning of the color will not take place. This point is of great importance, as O. S. Newman* has shown. Mr. Newman uses a long shallow copper pan, around the sides and bottom of which is circulated cold water. The syrup is cooled as it flows over the surface of the pan. Probably a vertical milk cooling coil would serve the purpose.

Storing the Syrup.—Cream of tartar separates from the syrup and will collect on the sides and bottom of storage tanks, from which it may later be recovered as a valuable by-product. Where storage tanks are available and clear syrup is desired, it will probably be advisable to store the syrup a month or longer.

Canning or Bottling the Syrup.—If the syrup is to go into cans or bottles it may go direct from the vacuum pan to these containers, which are sealed at once and are ready for shipment to market. If

* O. S. Newman, Manager of Woodbridge Vineyard Association, Woodbridge, California.

such containers are used, it is perfectly feasible to concentrate the syrup only to 64° or 65° Balling or Brix, heat it to 150° F. near the end of concentration and seal it hot in cans or bottles to destroy yeasts and molds. The yield of syrup is considerably greater at 65° Balling than at 70°, but it will not keep unless sealed hot or pasteurized after sealing.

Number 10 cans and gallon cans have been found very satisfactory as syrup containers and make a suitable size for soda fountain or household use.

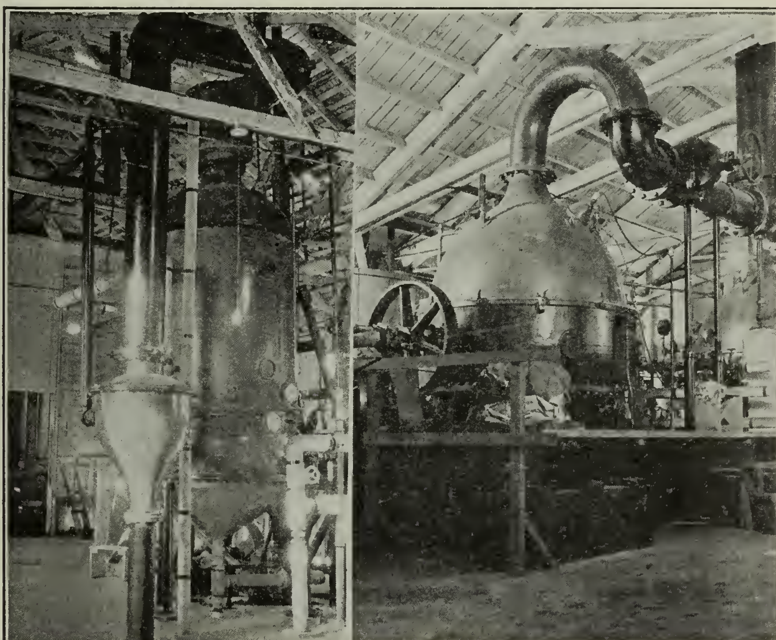

Fig. 5.—Two types of vacuum pans. On left, usual form of grape syrup pan; on right, pan equipped with stirring device.

Importance of Character of Lining of Vacuum Pans.—Most syrup pans are made of sheet copper and the juice is concentrated in contact with this metal. Analyses by C. H. McCharles and R. W. Bettoli* have shown that syrup containing sulfurous acid and concenterated in a copper vacuum pan may contain as much as seventy-five parts per million of dissolved copper, although in most syrups concentrated in this way the amount is much less. Two lots of syrup made in copper

* The writer wishes to thank Professor McCharles and Mr. Bettoli for these valuable data.

pans from unsulfured juice contained no dissolved copper. The maximum amount of copper allowed by the United States Department of Agriculture in gelatin is thirty-six parts per million; in most other food products, no copper is allowed. Whether the Department will rule against the presence of small amounts of copper in grape syrup is a question yet to be decided. Because the Department is desirous of promoting all new industries that will utilize wine grapes, it is believed that if the amounts of copper in the syrup are very small, no adverse action will be taken during the first season at least. A similar situation exists in regard to small amounts of copper in tomato products.

The interior of the pan may be silver-plated at a moderate expense. This metal is insoluble in untreated grape juice but dissolves rapidly in juice containing sulfurous acid. Tin linings are often used but tin dissolves in the juice rather rapidly and must be replaced in time. Retinning is extremely difficult for the special tubes used in such pans.

A good suggestion made by one vacuum pan manufacturer is to make the body of the pan of very heavily tinned or silver-plated copper and the boiling coils of Monel metal, nickel, or aluminum, all of which are insoluble in the juice. Aluminum, however, in time becomes pitted. Monel metal is insoluble and of high tensile strength, although somewhat more expensive than copper. Glass-lined vacuum pans may be used satisfactorily, although the evaporating capacity should be increased by installing inside the pan a Monel metal or other insoluble steam coil.

Loss of Juice by Frothing.—The pan should be deep enough or equipped with a trap to prevent loss of juice or syrup by frothing.

Syrup by Freezing.—The process described above results in loss of much of the fresh grape flavor. By means of a process developed by H. C. Gore of the United States Department of Agriculture, it is possible to retain practically all of the fresh flavor in concentrated form in the finished product. The Gore process is carried out as follows:

The juice is frozen to a solid mass at 10–15 degrees Fahrenheit. It is then broken in an ice-crushing machine. The crushed ice is placed in an ordinary sugar centrifuge and the syrup separated from the ice by centrifugal force. The syrup is thrown through the small holes of the centrifuge basket and the ice remains in the centrifuge. The syrup so obtained is again frozen at 0–10 degrees Fahrenheit to a mushy mass of ice crystals and syrup. By centrifuging this mixture a syrup of 50 to 60 degrees Balling is obtained. A small amount (about 1 per cent) of sugar is lost in the ice. Gore's work was done upon apple juice.

The writer repeated Gore's experiments with Muscat grape juice instead of apple juice. A syrup of 55 degrees Balling was as rich as it was found feasible to produce with the available equipment. The syrup was therefore not sweet enough for general use and would ferment quickly unless sterilized. Even a 60 degree Balling syrup is too "thin" and will not keep long. A 60 degree Balling syrup is the sweetest syrup recorded as having been produced by this process.

Therefore, it was found necessary to blend with this syrup obtained by freezing, a syrup of 70–75 degrees Balling made in an ordinary vacuum pan. The blend of 65 degrees Balling was very rich in flavor and far superior to any syrup that had previously come to the writer's attention.

Second crop Muscat grapes, which formerly were used for wine making, and can not be sun dried because of late ripening, would make an excellent syrup for blending purposes.

It was noted that the ice left in the centrifuge was sour in taste. When melted it was found to contain $^{75}/_{100}$ of one per cent of cream of tartar and a similar amount of sugar. On concentration of a sample of this liquid to a small volume most of the cream of tartar was recovered in a quite high state of purity. This suggests the possibility of obtaining cream of tartar as a valuable by-product.

The Gore process may be used without royalty charges because it is covered by a public service patent which makes the process public property. It is stated that the process is now used in a commercial way for the production of pineapple syrup.

PRESERVATION OF JUICE

Juice may be preserved in one of three ways for shipment to a syrup plant or storage at the syrup plant until needed.

By Pasteurization.—The juice may be heated to 175° to 185° F., run hot into sterilized barrels, and sealed. Most of the juice will keep, although some loss by fermentation will result. The method is troublesome and expensive, but could be used in case of necessity.

By Freezing Storage.—At 32° F grape juice will ferment, but will keep perfectly at 15° to 20° F. Large breweries are equipped with ample cold-storage facilities which might be used in conjunction with syrup factories located in such establishments. The fresh juice could be chilled by passing it over the coolers formerly used for chilling beer wort. The chilled juice could be stored in glass-lined or wooden tanks formerly used for beer, and could be removed and concentrated as needed. It would not repay other prospective manufacturers of syrup to install expensive cold storage equipment.

By Use of Sulfurous Acid.—Fermentation may be prevented by the addition of sulfurous acid. The amount necessary in hot localities is about $^{12}/_{100}$ to $^{15}/_{100}$ of one per cent., or, expressed in usual terms, 1200 to 1500 miligrams per liter. In cooler localities, 750 to 1000 milligrams per liter has been found sufficient.

Sulfurous acid may be had in several forms, such as a 6 per cent solution in water; or as the liquefied gas which is almost 100 per cent sulfurous acid; or as the salts, sodium metabisulfite and potassium metabisulfite, which contain about 50 per cent sulfurous acid.

The addition of 17½ gallons of 6 per cent sulfurous acid per 1000 gallons of juice corresponds to approximately $^{1}/_{10}$ of 1 per cent sulfurous acid. This corresponds to approximately 16 to 17 pounds of sodium or potassium metabisulfite per 1000 gallons of juice. If either of these salts is used it should first be dissolved in water; for example, at the rate of one pound per gallon. The sulfurous acid must be mixed thoroughly with the juice; this can be done by stirring with a wooden paddle or by compressed air. Metal should not be permitted to come in contact with freshly treated juice.

The juice should be cooled to 70° F. or less, if possible, before storage to insure the best results. Artificial cooling of juice from heated grapes will probably be necessary. The cooler the juice the less sulfurous acid is needed to preserve it. In our experimental work with 50-gallon lots, juice has been held for two years with $^{15}/_{100}$ of 1 per cent of sulfurous acid.

Juice containing sulfurous acid must be treated to remove as much of this preservative as possible before the juice is made into syrup. One method suggested and tested has been to heat the treated juice to 160° F. and pass a stream of air through it at this temperature. In small laboratory tests most of the sulfurous acid can be removed in this way, but upon a large scale the results have not been very satisfactory. The passing of steam through the boiling juice in the open air removes the sulfurous acid more rapidly than does a current of air; steam passed through the juice in a vacuum pan removes the sulfurous acid the most rapidly of any method tested, but the method offers mechanical difficulties when applied on a large scale. Dry steam must be used and the juice must be kept at the boiling point during the passage of steam to prevent a great increase in volume by condensation.

Simple concentration in a vacuum pan will remove a large amount of the sulfurous acid, as the following typical test by R. W. Bettoli will show: The origanal juice contained 1288 milligrams of sulfurous

acid per liter. It was concentrated to a syrup of 70° Balling under a vacuum. After concentration the finished syrup contained only 420 milligrams. Allowing a concentration of 3 to 1, this syrup after diluting with water to the original Balling degree of the juice would contain only 140 milligrams of sulfurous acid, indicating that about 90 per cent of the sulfurous acid was removed during the concentration. These results were confirmed by large-scale experiments by Mr. Bettoli and by laboratory tests by the writer.

A much better syrup can be made from the fresh untreated juice than from juice containing sulfurous acid. The removal of the sulfurous acid is incomplete and troublesome. Juice containing sulfurous acid is corrosive and attacks both copper and silver, necessitating the use of glass-lined or Monel metal or other resistant vacuum pans. For these reasons it is strongly advised that vacuum pans of sufficient size be installed to concentrate the juice from the grapes as rapidly as they are received; thus avoiding the necessity of using sulfurous acid. In other words, our advice is "Do not use sulfurous acid if it can possibly be avoided."

SUMMARY

1. As a result of laboratory and commercial experiments in grape syrup manufacture it is believed that a syrup of deep red color and rich berry-like flavor will give the best results from a commercial standpoint during the coming season. Other types of syrup with a larger amount of fresh grape flavor may in time supersede the type of syrup recommended above.

2. Large wineries already possess all necessary equipment for grape syrup manufacture except vacuum pans. Grape syrup manufacture can more readily be undertaken by such establishments than by small wineries. Milk canneries now equipped with large vacuum pans might well consider grape syrup manufacture as a profitable side line. Breweries, because of their large cold-storage capacity, steam plants, filtering equipment, etc., may easily be converted into grape syrup factories.

3. Vacuum pans should be constructed of materials not soluble in the juice. Copper has been the most common material employed, but analyses show that small amounts of this metal may dissolve in the juice during concentration. Therefore, the use of copper vacuum pans might in time conflict with the Pure Food regulations, and make the use of a material about which there is no doubt, highly desirable.

4. Syrup should be concentrated to 68° to 70° Balling if it is to be kept without sterilization.

5. The use of a high vacuum of 28 to 29 inches during concentration prevents injury to the flavor and color of the syrup by heat.

6. The syrup should be cooled after concentrating to avoid injury to color and flavor of the syrup.

7. Grape syrup has a great many different uses and its manufacture presents one of the most promising methods of profitably utilizing the crop of wine grapes of the state.

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